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ABSTRACT

This report is a review of the first 6 years of Industry Initiatives for Science and Math Education (IISME), a partnership between San Francisco Bay Area industries and the Lawrence Hall of Science. The program's mission has been to improve mathematics and science education by providing teachers with the practical applications of scientific concepts during paid summer industry internships, with follow up and educational support throughout the school year. This review includes: (1) a summary of the program, (2) program operations, (3) measures of program effectiveness; and (4) future directions. Appendixes include a list of the Board of Directors, Senior Advisory Council, and Sponsors; and a list of supplemental materials available upon request. (ZWH)

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ED 379 143

PARTNERS IN EDUCATION:

THE IISME EXPERIENCE 1985-1990

INDUSTRY INITIATIVES FOR SCIENCE AND MATH EDUCATION

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PARTNERS IN EDUCATION

1991 ADDENDUM

MILESTONES

After seven years of operation, Industry Initiatives for Science and Math Education (IISME) is a mature program with a measurably successful track record. In 1991, the program reached a number of milestones that reflect past efforts and proceeded with a strategic planning process to determine future directions. Some of the more important milestones include:

- reaching the 100 fellowship mark for the first time in Summer 1991
- offering over 500 fellowships cumulatively since 1985
- receiving $4 million in direct and in-kind support from 70 sponsors since 1985
- replicating the IISME model at 22 sites nationwide (5 in 1991 alone)
- expanding IISME's reserve fund to $53,000 (nearly five months of operating expenses)
- hosting a national conference for scientific work experience programs (70% of known programs from across the country sent representatives)

1991 PROGRAM EVALUATION

As important as these milestones are, the primary measure of IISME's effectiveness continues to be the changes in teachers' attitudes, instructional strategies, and course content that result from participation in the program. In 1991, as in previous years, more than 95% of our Fellows reported that the program was one of the best professional development programs in which they had ever participated. Other evaluation results from the 1991 End-of-Summer survey also closely followed the pattern from previous years (described in more detail in the 1985-1990 report). Some highlights in specific areas include:

Dissemination:

- 45% of Fellows brought colleagues or administrators to their summer workplace
- 76% are likely or very likely to share their experiences with school or community audiences
- 68% are likely or very likely to take on new leadership roles

Classroom transfer:

- 92% will give formal lessons on jobs or careers to their students
- 91% will include applications from industry in their course content
- 77% will invite their Mentor to school (In 1990, 50% of Mentors visited classrooms. In previous years, the average was 30%.)

Instructional Strategies

- 89% will assign projects with "real world problems"
- 87% will emphasize cooperative learning in their classrooms
- 84% will integrate math, science, and technology together in course content.

Industry Initiatives for Science and Math Education
Executive Office • c/o Deskin Research Group • 2270 Agnew Rd • Santa Clara, CA 95054 • 408/496-5340
Education Office • Lawrence Hall of Science, University of California • Berkeley, CA 94720 • 510/643-6594

Mentors

The 1991 Mentor Survey revealed that 95% of Mentors would rehire their teachers and are willing to be Mentors again. Forty-six percent reported donating supplies or equipment to their Fellow for instructional purposes. In the 1991 teacher survey, teachers reported a high degree of satisfaction with their Mentor/Teacher relationship. Seventy percent reported that their Mentors were knowledgeable and supportive of IISME's educational goals. Eighty-five percent reported that they were well-supported by their Mentor in their summer work assignment and in gaining exposure to company resources and personnel. In addition, the teachers reported that 68% of their Mentors helped or provided resources important in the development of their Action Plans.

1991 IISME SPONSORS

AT&T
Amdahl
Chevron
Collagen
Deskin Research Group
Dow Chemical
Dupont
El Camino Hospital
GTE
Hewlett Packard
IBM
Intel
Kaiser Permanente
Lawrence Hall of Science
Lockheed Missiles & Space Co.
National Science Foundation
NASA
NASA Ames Research Center
NEC Electronics
PG&E
Pacific Bell
Pacific Telesis Foundation
Raynet Corporation
Raytheon
Rolm Systems
Sandoz Crop Protection
Syntex
Triangle Coalition
U.S. Department of Energy
Watkins-Johnson

NEW DIRECTIONS

1991 was a pivotal year in planning program priorities and future directions. During the year, the Strategic Planning Process moved from a conceptual phase to a broad work plan. The next step, development of a five-year implementation plan will begin in January 1992. Already a number of new program operations have been initiated as a result of the strategic plan, including:

- assumption of administration of the SRC Competitiveness Foundation's VISION program in Northern California. VISION exposes teachers to industry ideas through an interactive lecture and tour format. Under IISME administration, VISION will be operated during the school year, allowing us to reach teachers who are unwilling to give up their summers to participate in our core program.
- increased collaborations with other organizations involved in mathematics and science education. Some examples include involvement with the Tech Museum of Innovation's efforts to support students participating in science fairs and technology competitions, providing teachers and Mentors to help develop classroom activities for Junior Achievement's Project Math, participation in Educational Partnership Week, and helping design the Bay Area Council's Access to Training project for teachers.
- development of a long-term evaluation strategy, including participation in a proposal to obtain funding for a multi-site, national effort to evaluate summer work experience programs for teachers.

TRANSITIONS

During 1991, Kathryn Sloane-Weisbaum resigned as Director of Education in order to pursue other research opportunities. She was replaced by geneticist Brian Kearney, who will work with Karin Rosman at our Lawrence Hall of Science office. In the Santa Clara office, Laura Horvath was hired to assist Marie Earl and Zina Segre in program administration and industry recruitment.

PARTNERS IN EDUCATION:

THE IISME EXPERIENCE 1985-1990

INDUSTRY INITIATIVES FOR SCIENCE AND MATH EDUCATION

OCTOBER 1991

INDUSTRY INITIATIVES FOR SCIENCE AND MATH EDUCATION

EXECUTIVE OFFICE

c/o Deskin Research Group
2270 Agnew Road
Santa Clara, CA 95054
(408) 496-5340

OFFICE OF EDUCATION AND RESEARCH

Lawrence Hall of Science
University of California
Berkelely, CA 94720
(510) 643-6594

Printing services provided by IBM

FOREWORD

This report is a review of the first six years of Industry Initiatives for Science and Math Education (IISME), a partnership between San Francisco Bay Area industries and the Lawrence Hall of Science. The program was founded in 1985 by a group of industry scientists, engineers, and managers from thirteen companies to address the critical need for a strong, skilled, creative workforce. IISME's mission has been to improve mathematics and science education by providing teachers with practical applications of scientific concepts during paid summer industry internships, with follow-up and educational support throughout the school year.

We are proud to report that IISME has had a number of successes in its first six years. We have reached a significant percentage of math, science, and computer science teachers in the region. We have enlisted the continuing support of local industries. We have had a concrete impact on teacher self-esteem, subject area knowledge, and retention in the teaching profession. We have significantly influenced curriculum presentation, lab work, and career guidance.

However, the need that IISME was created to meet has in no way diminished since 1985. In general, U.S. students continue to be woefully unprepared for the challenges presented by a highly technical, rapidly changing world.

Consequently, this report also outlines future directions the partnership will take to broaden its impact. We realize that no single program can address all aspects of the mathematics and science education crisis, but we do believe we can further leverage the deep commitment to education manifest in the efforts of our industry sponsors, mentors, and teachers toward meaningful progress.

The synergistic sharing of knowledge and resources between industry and education has been and continues to be a defining aspect of IISME.

As IISME enters its seventh year, we thank all who have participated in our early success, and we sincerely look forward to the challenges of the future.

Glenn T. Seaborg
Chairman
Lawrence Hall of Science
University of California

Stanley L. Karp
President, IISME
Manager, Administration
Raytheon Company
Semiconductor Division

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EXECUTIVE SUMMARY

Industry Initiatives for Science and Math Education (IISME) was founded in 1985 by a consortium of San Francisco Bay Area companies and government laboratories in partnership with the Lawrence Hall of Science at the University of California at Berkeley. IISME was founded to address the critical need for a strong, highly-skilled workforce in mathematics, science, and other technological fields. The IISME industry-education partnership focuses on ***teachers*** as the primary agents for affecting meaningful change in mathematics and science education.

IISME seeks to provide teachers with work experience in applied science and mathematics, as well as access to the latest technology and technically-trained professionals. IISME places science, mathematics, and computer science teachers (primarily high school level) in mentored, paid industry jobs during the summer months. The Lawrence Hall of Science office of IISME provides year-round assistance to teachers as they strive to translate their summer experiences into updated and enriched classroom instruction.

In the first six years of the program, 57 sponsor companies, hospitals, and government laboratories have offered 426 summer fellowships to teachers in the seven-county Bay Area. The 246 teachers who received these fellowships represent one-tenth of the Bay Area high school science and mathematics teaching force. Through these teachers, IISME-related ideas have reached over 250,000 students.

Through the IISME partnership, industry sponsors have contributed over $3 million to improving mathematics and science education in the Bay Area in the first six years of the program. In addition, the sponsors have contributed over 6,000 volunteer hours as Mentors to teachers, coordinators of the program within companies, guest lecturers in classrooms, hosts for company tours, and counselors to IISME and to schools.

Year after year, over 90% of IISME Teacher Fellows rate IISME as one of the best professional development experiences available to them. Similarly, over 90% of teachers annually report that their instruction has improved as a result of the IISME experience. Teachers consistently cite a renewed enthusiasm for teaching, better career counseling for their students, and more relevant, current curriculum and instruction as outcomes of their summer work. IISME teachers also increase their emphasis on teamwork, problem-solving, communication skills, and professional work habits in their classrooms. In addition, a recently completed survey

of all past participants in the program revealed that for 40% of teachers the IISME experience influenced their decision to remain in teaching. Nearly 70% reported that the IISME experience was a catalyst for further professional development.

Each year Industry Mentors report that the performance of their Teacher Fellows exceeded their expectations. The strong technical and communication skills, fresh perspectives, and abundant enthusiasm of teachers make them excellent, productive employees.

Mentors and teachers often collaborate on developing ideas for classroom transfer during the summer and over 85% of Mentors either make classroom visits or host students at the industry worksite during the school year. All Mentors and teachers become permanent members of the IISME Academy and are invited to participate in year-round academic activities. In addition, Mentors and teachers are able to communicate electronically through the IISME-NET telecommunications network.

As one of the oldest and largest programs of its kind, IISME has been instrumental in helping launch other IISME-like programs throughout the United States and abroad. Summer industry fellowship programs for teachers now exist in over half of the United States and in Denmark. Many other programs are in the formative stages.

This report summarizes IISME's first six years of operation. We describe the design and adminstration of the IISME model and provide an evaluation of the program's effectiveness. Sample materials that may be used to replicate the model are available upon request. (See Appendix for a listing of materials).

INTRODUCTION

As the twentieth century draws to a close, the United States is entering an era of unprecedented challenge. Political upheaval, rapid technological advance, and increasing international economic competition have shattered our old assumptions. A strong, skilled, flexible workforce trained in mathematics and science is critical to our nation's ability to compete in this changing environment.

Shortly after publication of the seminal report "A Nation at Risk," IISME was founded in the San Francisco Bay Area to enlist the resources and energy of industry in the mathematics and science education effort. Both then and now, IISME's mission has been to serve as a catalyst to increase the nation's scientific and technical talent pool, improve the quality of mathematics and science education for all students, and promote mathematics and science literacy in the population at large. We believe that a sustained, effective partnership between industry and educators is essential to accomplish this mission.

IISME's founders considered various models of industry/education partnerships and decided to focus directly on ***teachers*** as the primary mechanism for, and most important resource in, effecting meaningful change in mathematics and science education. At the heart of the IISME model are paid, summer internships for teachers in industry. There are two critical features that make this model work for improved classroom instruction:

- The IISME organizational structure is based on an equal partnership between the participating industry sponsors and an educational institution, the Lawrence Hall of Science. Our industry partners provide unique access to resources, experience, and insight into applications of mathematics and science concepts. The Lawrence Hall of Science provides the expertise and credibility that are instrumental in translating the summer experience into improved classroom instruction. Thus industry personnel and educators work together to design and implement strategies to meet the mutual goal of providing the best education for our youth.

- The summer work experience is intended to further the continuing professional development of IISME teachers. The summer job is not an end in itself. Our

goal is to empower teachers by providing them with experience and resources that will enrich the classroom experience of their students. The ideal summer position is challenging, revitalizing, and rewarding. When teachers take back to their classrooms new ideas and insights about their subjects, enthusiasm for trying new teaching strategies, up-to-date information for use in counseling students, and strong relationships with industry sponsors -- then IISME has achieved its goals.

Over IISME's first six years, the program has evolved into a strong, stable organization that will continue to make an impact on the state of mathematics and science education in the region.

IISME's greatest asset continues to be the ties we've helped create between industry and education. Through 1990, 57 corporations have participated in the program. More than 400 industry scientists, technicians, and managers have worked with 280 teachers from over 100 public and 30 private schools. Our sponsors have spent more than $3 million in direct support to teachers and the program. These sponsors have also provided more than $150,000 in donated supplies or services and over 6000 hours of volunteer time. In all, IISME has reached more than 10% of Bay Area high school mathematics, science, and computer science teachers who in turn teach more than 250,000 students.

Another important asset IISME has been able to develop over the past six years is credibility. Improving mathematics and science education means more than performing studies, publishing reports, and making recommendations. IISME has gone beyond rhetoric, enlisting industry and educator support to make concrete changes in the way science and mathematics are taught in our schools.

We have worked to leverage this experience and credibility to make a national impact. Twenty-two other scientific work experience programs for teachers in the United States and one program in Denmark have been developed using the IISME model. With support from the National Science Foundation, the Department of Energy, and the Triangle Coalition for Science & Technology Education, we are continuing our efforts to replicate the program.

The following chapters contain a description of how the program works, an evaluation of what we have been and have not been able to accomplish, and a preview of the directions the program will take in the future. The challenge before us remains as massive as it is critical, but we have confidence that our industry sponsors, mentors, and teachers working together will continue to progress toward the goal of national mathematics and science literacy.

PROGRAM OPERATIONS

PROGRAM ADMINISTRATION

LEADERSHIP

Leadership for the IISME program is provided primarily by a Senior Advisory Council and the IISME Board of Directors. The Senior Advisory Council is composed of six senior level executives of IISME sponsor companies, the Chairman of the Lawrence Hall of Science, and an educational leader from a local school district. The Council meets twice a year to provide general guidance and to assist with resource development. IISME's policies and procedures are determined by the IISME Board of Directors. The Board meets quarterly and is composed of 20 representatives of IISME-sponsoring organizations, the Director of the Lawrence Hall of Science, several educational leaders, and a teacher. The IISME Executive Committee is a subset of the Board responsible for strategic planning. Board members also serve on special interest and *ad hoc* committees. (See Appendix for rosters of the Senior Advisory Council and Board of Directors.)

FINANCES

Prior to the spring of 1987, all teachers were hired directly by their host companies and the IISME operating budget was derived from contributions made by these host organizations. Companies were not required to make contributions to the program in order to hire teachers, although most did. Contributions varied from company to company, and responsibility for support of the program was not equitably distributed in relation to the number of teachers employed.

In the summer of 1987, IISME became a nonprofit, tax-exempt public benefit corporation (501)(c)(3) and implemented a new fee-based structure. Sponsors were charged $800 a week for eight weeks for each teacher hired. Teachers received $600 a week; $200 a week was paid to IISME to support education activities, research, and administration. In 1988, this structure was modified slightly to allow companies employing large numbers of teachers to use a "sliding scale" for the fee paid to IISME.

In 1990, the Board approved three revisions to the stipend/fee structure. Teacher stipends were increased to $700 a week to keep them comparable to increased teaching salaries. Companies choosing to carry teachers on their own payrolls still paid IISME $200 a week; companies choosing to hire teachers

through IISME paid $300 a week to IISME (to reflect payroll costs borne by IISME). Finally, discounted fees for volume hiring of teachers were eliminated, as they had not proven to be a significant incentive.

Since 1987, more companies have opted to hire teachers through IISME rather than to enroll teachers directly on company payrolls. Teachers on the IISME payroll submit timesheets to IISME which are the basis for invoices sent to companies. IISME pays the teachers' stipends, payroll taxes, and workers' compensation insurance.

IISME forwards a portion of the program budget to the Lawrence Hall of Science each year to cover the operational expenses of the education component. Historically, this payment to the Lawrence Hall of Science has ranged from $23,000 to $53,000 annually, representing 10-20% of the total IISME budget in any given year.

Both the IISME Education Office (as a program within the Lawrence Hall of Science) and the IISME nonprofit corporation itself solicit grants for support of IISME projects. The IISME corporation has sought support from corporate and private foundations for general operating funds and replication of the IISME model. The Lawrence Hall of Science has received funding for the education component, including implementation of the telecommunications network, curriculum development, and Academy activities. In the first six years, these contributions have totalled more than $3 million. In addition, sponsors have contributed over $150,000 to both entities in in-kind resources including equipment, donated office space and services, Academy support, and printing of materials.

STAFFING

The IISME non-profit corporation employs an Executive Director and support staff who are responsible for administering the program, including industry recruitment, teacher placement and payment, program replication, public relations, and special projects. The Lawrence Hall of Science employs the Director of Education and Research and support staff who are responsible for teacher recruitment, outreach to school administrators, summer and academic year educational support services, and program evaluation.

Within participating companies, an on-site sponsor company coordinator serves as the primary liaison between the IISME staff and company personnel. The coordinator's responsibilities usually include identifying Industry Mentors, overseeing the development of summer jobs, distributing IISME materials and information, facilitating payment to IISME, and assisting with the teacher interview and selection

process. Most coordinators also arrange for teachers to attend tours, meetings, and training classes and provide access to other company resources.

Industry Mentors are employees of sponsoring companies who work closely with and provide guidance to Teacher Fellows during the summer. The Mentors act as liaisons between the teachers and their sponsoring companies. Mentors are often active in academic year follow-up as well, visiting schools or inviting students to their industry sites.

PROGRAM TIMELINE

As the IISME program has grown to serve larger numbers of teachers, deadlines for submission of teacher applications and company job descriptions have been moved forward. The current timeline is as follows:

December 1	Application Deadline for Teachers
January 1	Companies Commit to Positions
February-April	Job Descriptions Submitted
	Job Interviews Take Place
May 1	Job Placements Completed
Late June - Late August	Fellowship Period

PROGRAM PARTICIPANTS

INDUSTRY SPONSORS

Fifty-seven San Francisco Bay Area companies, hospitals, and government research laboratories have supported the IISME program in its first six years by hiring teachers during the summer and/or making financial or in-kind contributions.

IISME sponsors enrich the summer experience for teachers by providing access to such company resources as training programs and tours. Many companies donate equipment and monies for classroom use and most encourage Mentors to visit classrooms and students to visit the industry worksite. Both IISME's educational offerings (Academy sessions) and the IISME-NET telecommunications network are financially supported by industry and reinforce relationships formed during the summer.

During the pilot year of the program, 44 teacher fellowships were awarded. In the following five years, the total number of jobs offered in any given summer ranged from 65 to 88. The roster of companies hiring teachers varies each summer, usually reflecting the relative financial health of the companies. A core group of companies has participated at least four of the first six years. Core companies include: AT&T, Amdahl, Chevron, Dow Chemical, Dupont, GTE Government Systems, Hewlett Packard, IBM, Lockheed, Pacific Gas and Electric, Pacific Bell, Raytheon, Syntex, and Westinghouse. Teacher placements within companies range from a single teacher to as many as fifteen teachers at the Bay Area's larger employers such as Lockheed and Syntex.

IISME maintains a short-term goal of placing 100 teachers each summer in industry jobs. In 1991 (a year not covered in this report) this goal was met for the first time. Continued operation at this level will require a healthy economy, increased recruitment efforts, and a minimum applicant pool of 175 teachers.

IISME's recruitment strategy has been to place highest priority on expanding the program within existing sponsor companies. In addition, the IISME staff works with the Senior Advisory Council and the Board of Directors to generate an annual list of prospective companies based on prior contact, profitability, number of employees, location, etc. Members of the Senior Advisory Council and Board of Directors often contact peers within their own or other organizations to further IISME recruitment efforts.

IISME provides a Coordinator's Manual to company coordinators in December of each year in order to facilitate corporate administration of the program. This handbook contains sample job listings from prior years, advice on shaping appropriate jobs for teachers, and a suggested calendar of company activities for the summer. Since IISME emphasizes sustained sponsor involvement, the IISME staff works closely with company personnel to ensure the best possible match of teachers to jobs and to tie recruiting efforts to corporate budget cycles. During briefing sessions for interested company personnel, IISME strives to communicate program goals, participant responsibilities, and positive outcomes for both the teacher and company.

PROFILES OF TEACHER APPLICANTS AND IISME FELLOWS

Both public and private school teachers from the seven-county Bay Area (Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, and Santa Cruz Counties) are eligible to participate in IISME. Mathematics, science, and computer science

are the subject areas targeted by the program, but business, vocational or technical education, industrial arts, and other teachers have participated as well. The eligible pool of high school mathematics and science teachers consists of approximately 2,500 teachers. Since 1985, IISME has received 1,320 applications, but nearly half of these were from repeating applicants. About 704 teachers or an estimated 28% of the total number of high school science and mathematics teachers in the Bay Area applied to the program between 1985 and 1990.

DISTRIBUTION OF APPLICANTS AND IISME FELLOWS 1985-1990

The number of applicants to the IISME program and the number of fellowships awarded 1985-1990 are shown in Figure 1.

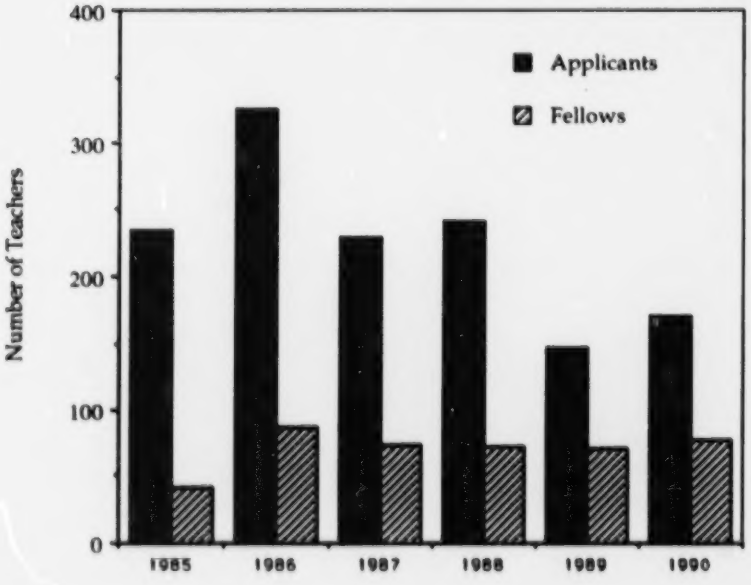

Figure 1. Numbers of Applicants and Fellows 1985-1990

The size of the applicant pool has decreased from over 300 in the program's first full year of operation (1986) to less than 200 in 1990. There are a number of possible reasons for the decline. First, the quality and quantity of summer programs for mathematics and science teachers in the Bay Area have improved dramatically

over the past six years. Nearly 70% of former IISME Fellows report that the IISME experience enhanced their working skills and encouraged them to seek out other professional development opportunities.

We know that some teachers have become discouraged from applying after not being placed one or more years. Some teachers believe the program to be too competitive and demanding, given their background and skills. In addition, the program requires giving up almost the entire summer vacation. In response to a survey we conducted, the majority of teachers who did not apply indicated that they reserved summers for travel or other pursuits.

QUALIFICATIONS OF APPLICANTS

Over the first six years of the program, the quality of the applicant pool has continued to improve both in terms of skills sought by employers and in skills related to classroom instruction. For example, in the area of computer skills, over 80% of 1990 applicants have word processing skills. In the same pool of teachers, 70% have basic programming skills.

GEOGRAPHIC DISTRIBUTION

IISME recruits teachers and industry sponsors from the seven-county Bay Area, but traditionally most of the applicants and jobs are concentrated in Santa Clara, Alameda, and Contra Costa Counties. For many teachers, participation in the IISME program involves a substantial summer commute. Teachers from counties where IISME does not offer many jobs have applied to the program in fewer numbers in recent years.

GENDER, ETHNICITY, AND NUMBER OF YEARS TEACHING

For the years 1986 through 1990, approximately two-thirds of applicants and Fellows were male and one-third were female. These percentages are roughly equivalent to those of the teacher population for the state of California.

Similarly, ethnic distribution of IISME applicants and Fellows is consistent with the teacher population. Approximately three-fourths of the applicants to the IISME program between 1987 and 1990 have been white. The percentages of African Americans, Hispanic, and Asian/Pacific Island applicants are low (below 10% for each group) (Figure 2). In recent years we have placed a higher priority on finding jobs for teachers of color.

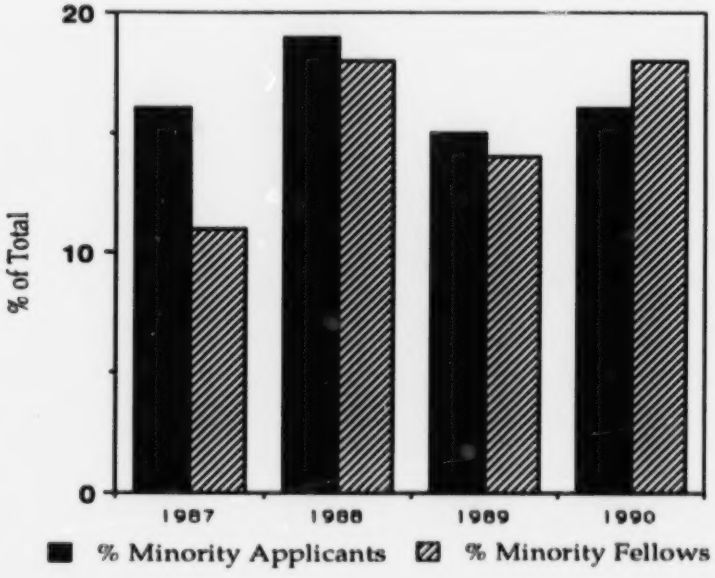

Figure 2. Minorities as a Percentage of Total Applicants and Fellows 1987-1990

Applicants and Fellows have taught an average of 12 years. Teacher experience falls into a bimodal distribution. The vast majority of IISME Fellows have between 2 and 10 or greater than 20 years teaching experience.

SUBJECT AREA AND GRADE LEVEL

Historically, IISME has concentrated its teacher recruitment efforts at the high school level. These teachers generally hold undergraduate or higher degrees in a science or mathematics-related field, making them desirable employees for sponsor companies. Increasingly companies are indicating a willingness to hire middle and junior high school teachers (who may or may not have the same level of academic preparation as high school teachers). These companies recognize that students often decide whether to pursue higher level mathematics and science coursework before they reach high school. IISME is currently directing a pilot outreach effort to recruit more middle and junior high school teachers into the program.

Many IISME teachers teach more than one subject. Mathematics, chemistry, and computer science are the subjects taught by the largest numbers of Fellows,

followed by biology and physics. A small percentage of IISME Fellows teach industrial arts, English, or business.

COMPUTER SKILLS

Nearly all IISME jobs require computer skills. Some jobs require a combination of skills; others require a specific computer language; some only require computer (usually IBM-PC) familiarity. Of the 78 job descriptions received in 1990, only ten did not require computer skills. The breakdown of computer skills specifically requested by sponsors of the 78 jobs awarded in 1990 was as follows:

Computer Skill	Number of Jobs
Programming	15 (3 - UNIX)
Wordprocessing	20
Spreadsheets	18
Databases	14
Graphics	6
Computer Aided Design	2

The level of computer skills of applicants and Fellows has increased over the past six years. This may be due to the increased use and availability of computers in the schools, to increased use and study of computer applications by teachers apart from their teaching duties, or to greater self-selection in the applicant pool.

REPEAT APPLICANTS AND RETURNING FELLOWS

As the IISME program has matured, the number of repeat applicants has become substantial, reaching a high of nearly 60% in 1989. Correspondingly, there has been an increasing number of returning Fellows, ranging from 46% to 54% over the past six years. These teachers are successful IISME Fellows who are perceived as seasoned employees by sponsor companies and who can provide support to first-time IISME Fellows.

TEACHER PLACEMENT

RECRUITMENT

Teacher recruitment begins in September for the following summer. Announcements are mailed to all public and private schools in the seven Bay Area counties served by IISME. An information packet containing a letter, an IISME brochure, a flyer (with a tear-off IISME application request) to be posted at school, and an IISME application are sent to every vice principal, mathematics department chair, and science department chair in the Bay Area with the request that these materials be disseminated to qualified teachers. In addition, with the use of National Science Teachers Association mailing labels, application-request flyers are mailed directly to teachers at their school address. In all, IISME mails approximately 4,000 information packets for teacher recruitment.

IISME originally recruited only teachers of grades 9 through 12, but the program recently has been opened to teachers of grades 6 through 8 as well. In order to qualify for a fellowship, a teacher must have completed at least two years of full-time teaching (after completion of student teaching). Teachers who have completed fewer than two years of teaching typically do not have enough general classroom experience to successfully achieve the required industry-to-classroom transfer.

In recent years, IISME has piloted efforts to encourage more fellowship applications from under-represented teachers and teachers reaching students of color and "at-risk" students. Target districts, defined as school districts where students of color constitute a majority, are the focus of intensive recruitment efforts. Special mailings, phone calls to school and district administrators, and presentations to district teachers by colleagues who have participated in IISME are among the strategies we have used to encourage applications from target districts. In general, direct personal contact with teachers has been our most successful recruitment strategy, and we make every effort to place all specially recruited applicants in jobs.

Sponsor companies are increasingly interested in hiring Fellows from districts in their community, from schools with which they have pre-existing partnerships, or from IISME's target districts. IISME supports and facilitates these requests as well.

EVALUATION OF APPLICANTS

Applications are submitted to the IISME Education Office for a preliminary screening. Each application is reviewed and a priority rating code is assigned based on the following education-related criteria:

- Commitment to education and teaching
- Professional development activities (quantity, quality, consistency)
- Leadership or leadership potential (at school or district level, within professional organizations)
- Willingness to try new classroom approaches
- Communication skills (as demonstrated in the applicant's personal statement)
- Special efforts on behalf of students (extracurricular activities, enrichment programs)
- Student population (ethnic composition, "at-risk")
- Teacher ethnic background
- First-time Fellow or returning Fellow demonstrating effective transfer of previous IISME experience

The assigned code is for IISME staff use only and is not shared with teachers or sponsors. Applicants with a rating code of 1 are matched first to any job for which they are qualified; rating code 2 represents the general applicant pool; rating code 3 represents low-priority applicants; rating code 4 is assigned to applicants who are ineligible for fellowships.

MATCHING TEACHERS TO JOBS

Following the evaluation of teacher applications, most of the application data are entered into dBase III+ for job matching (and later for generation of reports and a fellowship telephone directory).

Job matching proceeds in the order in which job descriptions are received at the IISME office. The job match process focuses on three primary criteria given by industry sponsors on the IISME job description form: the teachers' educational

background, computer skills, and willingness to commute to a job site. The internally assigned priority rating code provides a fourth criterion for the job match. Two or three applications are forwarded to the company coordinator for each job description received.

Teachers are notified of referrals at the time IISME mails their applications to industry sponsors. Mentors are urged to screen candidates carefully and to conduct personal interviews, evaluating the teachers as they would any potential new employee. In the early years of the IISME program, candidates were referred to only one company at a time. For the last several years, teacher applications have been submitted to several companies at the same time. This "free market" referral system spurs Mentors to interview and make hiring decisions as quickly as possible. Nearly all applicants are referred for at least one job.

Once candidates have been referred to a company for a given job, weekly telephone calls are made to company coordinators or Mentors to track interviews and hiring decisions.

Since almost all applicants need summer employment, the pressure on teachers to accept a summer school assignment and on IISME to bring closure to hiring decisions is greatly increased by late April. Some applicants withdraw from the program if a promising job is not on the horizon. Every effort is made to impress upon company Mentors and coordinators the importance of making prompt hiring decisions. However, job matching continues into the second week of June, just before the beginning of the fellowship period.

Each year approximately 20 jobs have been withdrawn by industry sponsors, often late in the job match period. The reasons for job withdrawal vary greatly, ranging from changes in Mentor assignments and budgets to requests for lab or computer skills only rarely available among IISME applicants. When jobs are submitted to IISME very late in the process, sometimes suitable candidates are no longer available.

PARTICIPATION POLICIES

IISME allows teachers to return to work at the same company for no more than two consecutive years. This policy is designed to provide more diverse work experi-

ences for teachers, to prevent teachers from developing "ownership" of particular jobs, and to allow greater numbers of teachers to participate in the program. From 1986-1990 roughly one-half of participating teachers were returning Fellows.

The IISME Board of Directors has declined to place a limit on repeat participation for a number of reasons. The IISME program benefits from the insights and experience returning teachers contribute, as do the companies who hire returning Fellows. The nature of some fellowship assignments is highly technical and skill-intensive, and some Mentors have invited the same IISME Fellow back a second year to take advantage of prior training.

Teachers certainly benefit from multiple experiences in industry, and there is preliminary evidence to suggest that the outcomes of the summer experience develop and evolve with each year of participation. Finally, returning Fellows provide valuable help to teachers participating for the first time.

The only rules regarding teachers reapplying to the program are:

- Returning Fellows must have fulfilled all their program obligations (including filing an Action Plan and completing evaluation forms)
- Returning Fellows must demonstrate that they have translated their previous IISME experience into improved classroom education for their students.

EDUCATION ACTIVITIES AND SUPPORT

The ultimate goal of all IISME efforts is to enhance classroom mathematics and science education. To that end, IISME's Education Office at the Lawrence Hall of Science sponsors a number of activities and provides academic support to Fellows during both the summer and the school year.

SUMMER PROGRAMS

During the summer fellowship period, IISME educational programs include: meetings held at the beginning, mid-point, and end of the eight-week session, a Peer Advisor, and company site meetings. The Education Office staff also assists Fellows as they develop Action Plans (projects for the classroom transfer of an aspect of their IISME fellowship).

ORIENTATION

Orientation sessions are held the week before the start of the fellowship period. All Teacher Fellows and Mentors are required to attend one orientation; company coordinators and the Board of Directors are also invited The purpose of these sessions is to:

- introduce participants to the goals, mechanisms, and expectations of the program
- give Fellow-Mentor teams an opportunity to meet and discuss plans for the summer prior to the first day of work
- offer strategies to help participants make the most of the summer experience as well as to maximize the potential for translating industry ideas and insights into classroom practices

Orientations are hosted by sponsor companies and feature:

- presentations by Fellow-Mentor teams from previous summers outlining suggestions for working together successfully and for collaborating on classroom transfer strategies
- small group meetings of teachers and industry personnel (grouped by company or geographic area) to discuss expectations for the summer, plan group activities for teachers at the industry site, review types of company resources available to the teachers, and build team spirit

All participants receive an IISME Orientation Manual. This manual includes a description of the program and program requirements, a glossary of IISME terms, a calendar of events, and sets of tips and guidelines for Fellows and Mentors to assist both in making the most of the teacher's summer experience.

MIDSUMMER MEETING

The Midsummer Meeting, held for Teacher Fellows in mid-July at the Lawrence Hall of Science, provides an opportunity for teachers to work intensively on developing strategies for classroom transfer and applications of the summer industry experience. The meeting is held over one full work day. Fellows spend much of the day in small working sessions, grouped according to interest, to discuss successfully transferring concepts and resources from industry to the classroom, the workforce of the future, and subject or content areas.

END-OF-SUMMER CELEBRATION

An event celebrating the successful completion of the summer program is held during the last week of the fellowship period. All Fellows, Mentors, company coordinators, principals, and district superintendents are invited to attend.

PEER ADVISOR

A returning IISME Fellow acts as Peer Advisor to the Fellows, visiting them at their industry sites during the summer. The Peer Advisor provides various kinds of support, including consultation with Fellows on Action Plans (suggesting ideas and resources where appropriate and disseminating previous Action Plans), facilitating communication between Fellows at different sites, assisting first-time Fellows who may need additional support, and acting as a trouble-shooter for any problems that arise. The Peer Advisor position was originally funded by a grant from the National Science Foundation, and yielded such positive benefits that the position is now funded by an industry sponsor each year.

COMPANY SITE MEETINGS

Fellows are encouraged to meet together regularly over the summer at their company sites. Sites with only one or two Fellows are encouraged to join a group at a neighboring site. Some groups meet informally, others choose to meet for scheduled activities such as company-sponsored tours or training sessions. These meetings reduce feelings of isolation among Fellows (reported in the earlier years of the program) and provide Fellows with critical opportunities to explore the educational implications of what they are experiencing in industry in an informal and collaborative setting. Those Fellows who establish a network of colleagues over the summer report having a more rewarding experience.

SPECIAL EVENTS

Some sponsor companies voluntarily open company tours and luncheons held over the summer to all IISME Fellows. IISME encourages sponsors to consider planning such events and facilitates Fellows' participation when these events are offered.

CERTIFICATES

Certificates recognizing the Teacher Fellows' participation are sent to principals in September, with the request that they be awarded to teachers in a manner which acknowledges the teacher's special efforts and contributions. Many principals present the certificates to the teachers at faculty, school board, or other public

meetings. Certificates acknowledging the contributions of the Mentors are sent to company coordinators with a similar request. Company coordinators are also awarded IISME certificates. These certificates seem to be appreciated by all recipients, and they help ensure that participants' efforts are acknowledged by their supervisors.

ACTION PLAN

Each Teacher Fellow is responsible for producing a plan for the classroom transfer of some aspect of their IISME experience. Fellows are allotted 10% of their time over the course of the summer fellowship to devote to the development of this "Action Plan." Mentors are encouraged to participate in developing and implementing the Action Plan.

In the early years of the program, Teacher Fellows were required to submit a curriculum project at the end of the summer, describing lessons they had developed for their classroom based on their industry experiences. There were problems with this approach, however. For example, many teachers worked on industry job assignments that did not have direct applications to the content or level of the courses they taught. Developing new curriculum materials required considerable development time (difficult to achieve during full-time summer employment) as well as time to pilot, test, and revise. In addition, only a minority of the Fellows were experienced in or felt comfortable with writing curricula and thus the quality of the resulting projects was inconsistent. Finally, many teachers felt that the focus on content overlooked many of the salient and important implications the industry experience had for instruction.

IISME staff, with input from a team of veteran Fellows, revised and modified the classroom transfer requirement from the early curriculum project to the current Action Plan format. In particular, Fellows now develop their Action Plans around the IISME Thematic Areas. This list, identified by a consensus of Teacher Fellows, industry sponsors, and IISME staff, defines the most important educational outcomes of the IISME experience. (See Table 1.)

The Thematic Areas also provide a framework around which Fellows and Mentors can design an educationally relevant summer experience and supply topics for IISME Academy meetings. Of note among the Thematic Areas is the increased emphasis on instructional strategies to encourage students' skills in teamwork, communication, and problem-solving, and on teaching and reinforc-

ing good work habits. These skills were identified by industry as particularly important in preparing the future workforce, and identified by teachers as skills not traditionally emphasized in their classroom instruction, though vital to students.

Action Plans are submitted to IISME at the end of the summer, compiled into an Action Plan Catalog of short abstracts, and distributed to all past Teacher Fellows, Mentors, and interested colleagues. IISME also provides complete copies of Action Plans to other interested teachers upon request.

TABLE 1. IISME THEMATIC AREAS

- ***Teamwork***. Groups working together to complete a task, with different members having different responsibilities. Requires cooperation, ability to work with others, a sense of responsibility to the group.
- ***Problem solving.*** Planning and implementing change; risk-taking; developing a strategy or plan, then feeling a sense of ownership in the process; implementing and evaluating the effectiveness of the plan.
- ***Career Awareness.*** a) General information about careers and job opportunities in mathematics and science-related fields; b) emphasizing the importance of mathematics, science, and computer literacy in a variety of jobs and career choices, along with the importance of taking more mathematics and science; c) information about changes in careers and in the workforce over the next decades and the importance of a strong educational foundation that prepares students for rapid changes in jobs, technology, and society's needs.
- ***Interpersonal skills, communication skills, work habits and ethics.*** Working well with others; presenting information clearly and correctly in verbal or written reports; displaying a sense of responsibility for doing a job well and a commitment to professional ethics; practicing good work habits such as promptness, neatness, adherence to deadlines.
- ***Updating content*** of mathematics and science courses—revising or adding content by including relevant, up-to-date examples and illustrations from industry, or by introducing new topics not currently covered in the curriculum.
- ***School-industry interaction.*** Developing stronger bonds between teachers and their industry sponsors, and building a relationship between schools and industries; bringing industry personnel into the schools, or school personnel into industry settings, so that industry personnel and educators can share ideas, insights, and strategies for educational improvement; placing students in direct, consistent contact with industry personnel.
- ***Sharing the IISME experience.*** Sharing IISME-related ideas, information, and materials with other teachers, with school administrators, and with district or parent groups; developing leadership abilities in educational reform and improvement.

ACADEMIC-YEAR PROGRAMS

The IISME Academy is our primary mechanism of academic-year support and teacher networking. All Fellows and Mentors become permanent members of the Academy and are invited to attend Academy events.

In the early years of the program, Academy meetings were primarily education-based and usually included a speaker discussing some current topic in education or presentations by teachers on their classroom activities. While a useful vehicle for teachers to meet and share ideas, Academy meetings did not build effectively on the teachers' summer experiences, nor did they facilitate continued access to industry personnel and ideas.

The IISME Academy now offers four meetings each year. Two of these are industry-hosted. These meetings usually include a tour of an industry facility (research labs, manufacturing plant, etc.) conducted by industry personnel, a lecture or seminar on a technical topic, and time for small group discussions among teachers and industry personnel. The industry-based format is a highly desirable one, allowing teachers continued access to industry personnel, facilities, and ideas. Such access is not available through other, more traditional, staff development programs offered to teachers during the academic year, and represents a unique and important contribution by IISME to teachers' ongoing professional development.

Two Academy meetings are more education-oriented in the sense that they explore in-depth some educational topic, usually related to the Thematic Areas, and are often ***initiated by the teachers***. Teacher Fellows participate in defining the Academy topic, selecting speakers or presenters, and guiding the group discussion. These programs always include some participation by content specialists in the public or private sector and are designed to provide specific materials or information teachers can use in their classrooms. Occasionally, these meetings focus on an issue related to educational reform or teachers' professional development. For example, one Academy session focused on decision-making and problem-solving models used in industry, followed by discussion sessions in which teachers and their administrators applied these models to an existing problem in their schools. Table 2 contains a list of 1985-1990 Academy meetings.

Academic-year follow-up activities have expanded beyond offering Academy meetings. For example, we now send out regular updates or newsletters to all members of the Academy, sharing information of interest to teachers (Fellows'

activities, IISME-NET information, grants and funding opportunities for teachers, professional development opportunities, award competitions, etc.). We have offered workshops for first-time applicants and hands-on workshops in MS-DOS for applicants and interested Fellows (many teachers are familiar with Apple computers but not the MS-DOS environment, which is most common in the industry environment).

TABLE 2. IISME ACADEMY 1985 - 1990

Date	Academy Title
1/86	Teacher Follow-up Meeting
5/86	Information Sharing & Planning
10/86	Information Sharing & Planning
1/87	Trends in Technology
6/87	Information Sharing & Planning
2/88	Has IISME Made a Difference?
10/88	Generating a Problem-Solving Approach which can be shared by Education and Industry
12/88	A Software Review
3/89	Hypercard in the Classroom
5/89	Review of 1988 Classroom Applications
9/89	The Making of the Silicon Chip (Raytheon)
12/89	Loren Acton (Astronaut): Space Station Preview(Lockheed)
2/89	Networking Lab & a Software Review
3/90	Teaching Problem-Solving in Real World Contexts
5/90	Environmental Issues Session & Tour (IBM)
5/90	A Celebration of IISME's First Five Years (Pacific Bell)
10/90	Networks & Health Care (Kaiser Permanente)
12/90	Designing Interdisciplinary & Issue-Based Environmental Education

IISME-NET TELECOMMUNICATIONS NETWORK

IISME has been able to establish the IISME-NET telecommunications network thanks to support from AT&T, IBM, the National Science Foundation, and Pacific Bell. As initially conceived by a group of IISME Fellows, IISME-NET addresses several needs of teachers: a) reducing the isolation that plagues teachers once they return to the classroom; b) providing access to software, information systems, and databases unavailable to the average classroom teacher; c) providing a forum for sharing IISME-related ideas, classroom materials, and industry resources; and d) offering ready access to industry personnel as resources for teachers and their students throughout the year.

The network, housed at the Lawrence Hall of Science on an IBM-donated PS2/Model 80, currently has 200 registered users who together have contributed over 200 files to its databases. These files include Action Plans, other classroom lessons and activities, and a wide range of other supplemental materials and resources for teachers. The bulletin boards and message systems allow users to exchange ideas and information on available opportunities and resources and provides a source for assistance with a variety of telecommunications, technical, and curriculum-based problems and issues.

A toll-free telephone number is available for users. During the summer one or two veteran Fellows work as IISME-NET Fellows (initially sponsored by National Science Foundation funds, now industry supported). IISME-NET Fellows are responsible for the maintenance and development of the physical network and the content of databases as well as training all Fellows to use the network. During the academic year, IISME staff and teacher volunteers maintain the network.

While IISME-NET's potential has been clearly demonstrated, the network is an ambitious, labor-intensive project and a number of limiting problems persist. Included among these are:

- Many teachers lack access to the necessary hardware, modem, or phone line
- Communication and exchanges of files are hampered by incompatible hardware (e.g., Apples and PCs)
- Training users is made difficult by the teachers' varying computer skills and comfort-levels toward telecommunications and by the variety of hardware and software in use
- We have not yet been able to successfully attract many industry users to the network.

SPECIAL PROJECTS

The IISME Education Office seeks grant funding to pilot educationally-relevant special projects. The successes resulting from these pilot efforts can then be developed as permanent features of the IISME program. In 1988 IISME was awarded a two-year grant from the National Science Foundation which supported three interrelated areas of activity:

- enhancing classroom transfer (the Action Plan)
- expanding Academy programs
- developing the IISME-NET telecommunications network

In each of these areas, activities were designed and implemented through the collaboration of industry personnel, teachers, and IISME staff. The funds from the National Science Foundation enabled us to evaluate existing program features and make substantial modifications in some areas of the program.

The NSF grant supported a team of four veteran IISME Fellows who served as the Education Task Force during the summers of 1988 and 1989. This Task Force was charged with reviewing the classroom transfer project and was instrumental in the development of the current Action Plan model. These teachers also reviewed and made recommendations regarding other aspects of the summer program. For example, they introduced the idea of the Peer Advisor, a highly successful program addition which is now industry supported.

The IISME-NET Fellows were also supported by the NSF grant during the summers of 1988 and 1989 resulting in significant progress in the development of the telecommunications network during this period. The grant also supported the expansion and refinement of the IISME Academy.

Measures of Program Effectiveness

Program evaluation is an integral part of the IISME model. Systems for monitoring program operations, for assessing participant reaction to the summer fellowship experience, and for documenting the ways teachers use IISME-related ideas in their classrooms are built into the IISME model. We employ several different strategies for collecting the information necessary to monitor program operations and to assess program outcomes. Strategies include:

- Surveys administered to Teacher Fellows at the midsummer meeting, at the end of the summer fellowship, and during the spring semester of the following academic year. These surveys cover a wide variety of topics related to program operations, outcomes of the summer experience, and classroom transfer.
- Surveys completed by Industry Mentors at the end of the summer. These provide feedback on program operations as well as evaluations of teacher performance at the workplace.
- Staff visits to the company sites during the summer. A returning Fellow who serves on the IISME staff as a Peer Advisor conducts most of the visits to the Teacher Fellows.
- Informal talks with teachers, Mentors, and company personnel throughout the summer and the following academic year.
- Participant evaluation of each Academy meeting.

Further information on classroom transfer is also obtained from:

- Action Plans submitted by the teachers at the end of the summer;
- Implementation Reports teachers prepare at the end of the following academic year.

Feedback from teachers, Mentors, and company coordinators is vital in our efforts to provide a high-quality, enjoyable experience for the participants. Over the years, we have made substantial changes in program operations based on participant recommendations. For example, in response to comments that many Mentors were not fully aware of program goals, requirements, and expectations, we designed orientation materials specifically for Mentors and changed our

orientation procedures to involve Mentors more directly. Another significant change in program operation in response to participant feedback involved revising the teacher match process to:

- distribute teacher applications to multiple sponsors at once
- work more closely with sponsors to design jobs to fit teachers' interests and qualifications
- adjust the application deadline to accommodate school schedules and industry budget timelines

Continuous program evaluation enables us to gain a better understanding of the impact of the program on special subgroups of participants. For example, we have learned that teachers' perspectives of the industry experience and its classroom implications change as they gain more experience (through multiple fellowships) in the industry environment. First-year Fellows focus most on assimilating their experience and on finding ways to incorporate new-found ideas and materials into their classroom activities. We try, therefore, to provide more one-on-one support for these teachers and more assistance in gaining access to industry materials and resources during the summer. Veteran Fellows place relatively greater emphasis on the increased self-confidence and revitalization that the experience provides, while challenging IISME sponsors to become more involved in the "larger issues" such as educational reform.

Results from the evaluation data collected for the first six years of the IISME program are summarized in the following sections.

Note: more detailed analyses and discussions of evaluation results are presented in the Annual Program Reports for the years 1985-1989.

To date, evaluation efforts have been primarily "formative," that is, focused on understanding the ***meaning*** of the experience for participants and on identifying areas of the program in need of improvement. As will be discussed, we are currently designing procedures to explore the longer range outcomes of the IISME experience in terms of teachers professional development and student outcomes.

In the following sections, program effectiveness is discussed in three categories: a) corporate satisfaction; b) effects on teacher professional knowledge and attitudes; c) impact on classroom instruction, career counseling for students, and direct student access to industry personnel and resources.

MEETING INDUSTRY GOALS AND EXPECTATIONS

IISME corporate sponsors participate in the program because they believe in the goals of IISME and have an explicit commitment to becoming more involved in supporting education. For some companies, IISME is their primary method of educational involvement, but for many others IISME represents one of a number of educational programs they support. While there are a small number of companies that rotate in and out of IISME sponsorship, a core group of over a dozen companies has maintained and increased their sponsorship of IISME teachers since 1985. For these sponsors, evidence of the immediate benefits (observed first hand and documented in annual evaluation reports) and belief in the long-term benefits of IISME validate their continued involvement and support.

When IISME was first established, many corporate sponsors viewed the summer fellowship as a benefit the companies provided for teachers. Few saw the potential benefits to the company. Over the years, however, corporate sponsors have become quite enthusiastic about the "two-way" exchange of expertise and ideas resulting from the partnership.

The most immediate benefits to industry for offering IISME fellowships are the contributions and accomplishments of the teachers during their summer work assignments. Mentor evaluations of their Teacher Fellows' job performances are overwhelmingly positive each year. Fellows are perceived as highly organized and self-motivated, capable of establishing objectives and meeting deadlines. Teachers approach their summer assignments with initiative, possess excellent communication and organizational skills, and participate as valuable team members.

Mentors also appreciate the new perspectives and abundant enthusiasm teachers bring to the workplace. Many employers find that company participation in the IISME program provides a morale boost for employees, who are impressed by the corporate commitment to the community.

The primary concern of industry participants is that teachers return to classrooms with the skills and insights needed to prepare their students to be members of a scientifically literate workforce. With a view towards the future workforce, Mentors value the IISME fellowship as a way for teachers to understand and transmit to their students the needs and challenges of the high technology business and science environment.

IISME encourages Mentors to continue their relationships with teachers after the summer fellowship, to visit their teachers' schools and classrooms, to host tours or industry-based events for students, and to become directly involved in planning and implementing classroom activities. This type of industry involvement gives students direct access to industry personnel and resources and contributes significantly to teacher efforts to motivate and encourage student interest in mathematics and science related careers. And industry personnel gain a better understanding of the demands and constraints teachers face, as well as a greater appreciation of the caliber of teachers in the schools.

BENEFITS FOR TEACHERS

Each year, over 90% of Teacher Fellows rate IISME among the best (top 10-20%) of their professional development experiences. In this intensive "immersion" experience in applied industry settings, teachers learn ***by doing***. They apply their own academic and technical knowledge to the tasks at hand, learn about current research and development efforts in their fields, gain on-the-job experience with state-of-the-art equipment, and draw upon their expertise in interpersonal relations to work with diverse groups of professionals. The summer setting and experience are completely different from traditional forms of professional development and training in education, and the types and range of outcomes teachers report reflect these differences. While each teacher's on-the-job experience varies, consistent themes and patterns have emerged from teachers' reports of the personal and professional benefits gained from the summer fellowships.

At the end of the summer, and again during the academic year, we ask the teachers to define (and/or rate) the professional outcomes of the IISME experience. Over the years, teachers have repeatedly and consistently stressed the importance of changes in their own professional attitudes and knowledge, as the immediate outcomes of the summer experience. New insights and information, coupled with increased self-confidence and renewed enthusiasm, enable teachers to translate their industry experience into new classroom practices, designed to make course content more interesting and relevant for students and to encourage students to consider careers

in mathematics and science. Further, there is increasing evidence to suggest that, particularly for returning Teacher Fellows, IISME has a long-term impact on their continuing professional development and their involvement in school improvement and educational reform.

In Table 3 (on the next page), the cumulative percentages of IISME teachers since 1985 who have reported improvements in their professional knowledge, attitudes, or teaching strategies are presented. In the following sections, we describe what these outcomes mean for participants. Data from a 1991 survey administered to all Teacher Fellows (1985-1990) are included to demonstrate the continuing effects of IISME participation.

CHANGES IN ATTITUDES

Perhaps the most notable result of the summer in industry is the impact on teachers' views of themselves as professionals and their attitudes toward the teaching profession.

Each year, most of the Teacher Fellows (80-90%) rank "increased self-confidence" as one of the most important outcomes of their IISME experience. Successfully completing a challenging job in their academic field, being treated as a professional by their industry colleagues, discovering they have the skills and knowledge to perform in a completely different environment—all contribute to an increased sense of self-confidence and self-worth.

About 85% of the teachers cite "revitalization" and "renewed enthusiasm for teaching" as important outcomes of the IISME experience. Contrary to early concerns that teachers would flock to industry jobs after their summer fellowships, most teachers feel that their summer experience renews their commitment to teaching as a profession. In a 1991 survey of all past IISME participants, 40% of teachers indicated that IISME had played a role in their decision to stay in teaching. While teachers gain self-confidence from knowing they can do a good job in industry, they also gain a clearer sense of why they teach and why they enjoy teaching.

Inspired and motivated teachers can make a real difference in classrooms. Teachers have described new excitement and energy in their classrooms. Their own enthusiasm for the subject matter and its applications in technology and product development elevates the value of mathematics and science in their

Table 3. Percent of IISME Teachers Reporting Improvement in Professional Knowledge, Attitudes, and Teaching Strategies as a Result of their Fellowships

Professional Knowledge and Attitudes	'90	'89	'88
Attitudes			
increased self-confidence	70%	93%	88%
revitalization	86	87	83
renewed enthusiasm	84	84	78
Knowledge			
knowledge of application	75	89	83
knowledge of subject	67	78	81
new perspectives on subject	72	85	81
new perspectives of teaching subjects	50	62	62
career information	84	94	90
Instructional Goals & Strategies	**'90**	**'89**	**'85-88**
Career Counseling			
info on career preparation	96%	97%	60%
formal "career ed" lessons	77	63	60
Skills Development			
teamwork	91	97	70
communication skills	96	68	70
work habits	90	80	65
Content			
examples & illustrs. from industry	90	90	80
add new lessons or labs	61	70	50
revise lessons or labs	85	85	50
new problem solving assignments	87	82	50
more technology	83	81	—
integration of math & science	85	85	—
Access to Industry			
materials, equipment to teacher	45	58	50
use of industrial materials in class	53	59	31
field trips to industry	32	36	30
indust. personnel in classroom	50	39	30
ongoing contact with Mentor	73	64	—

students' eyes. Having actually worked in industry, teachers respond with experience and authority to queries about the usefulness or relevance of the subject matter, and the teachers report that they enjoy this enhanced credibility. Returning to the classroom after a successful experience working in industry, teachers also demonstrate to students that they value and are committed to the teaching profession. Students often ask their teachers why they are teaching, if they could work in industry; I'm here because I *want* to be, the teachers respond.

In the 1991 follow-up survey of all Teacher Fellows, over one-third (36%) said the primary benefit of IISME participation was the personal or professional "boost" they received as a result of their experience. This suggests that the attitudinal changes persist long after their summer fellowship, and is an important outcome of our program.

PROFESSIONAL GROWTH

In the 1991 survey administered to all Fellows, 70% of the teachers rated IISME as having a strong effect on their professional growth and development. For these teachers, the IISME experience served as a catalyst for them to pursue new professional development activities or to tackle new professional challenges. From the teachers' comments , we interpret this catalyst effect to be the result of the increased self-confidence and professional self-esteem teachers gain during their IISME fellowships.

The effect of IISME as a catalyst for professional growth increases with the number of years teachers have participated in the program. Fellows who had participated four years rated the effect 4.83 out of 5 (mean rating) compared to 4.20 and 3.76 for Fellows who had participated two or one years, respectively.

Examples of the professional activities teachers were inspired to pursue after their IISME experience fell into seven categories, listed in descending order of frequency:

- improving classroom instruction
- assuming new leadership roles in school or district
- pursuing more professional development (classes, workshops)
- developing or redesigning curriculum

- assuming new professional responsibilities (e.g., dept. chair, committees)
- developing new computer curriculum or enrichment programs
- participating more actively in school restructuring, education reform

KNOWLEDGE OF THE INDUSTRY ENVIRONMENT

In open-ended survey questions (and in site visits or informal interviews), we ask teachers to describe new information or insights they have gained from their summer experience. Frequently, teachers first describe the differences they observe between the industry and school environments. Particularly for first-time Teacher Fellows, these differences are quite striking.

Through their summer experiences, teachers gain first-hand knowledge of the demands and expectations of the industry environment. They gain a better understanding of what type of work actually goes on in a company and the industry's perspective on issues related to the environment, the community, and public policy. As an example, teachers who work for chemical companies often report a greater understanding (and respect) of the company's policies regarding employee safety and environmental impact.

Across all industries, teachers compare the demands and expectations of the industry environment to those of the school environment. For many IISME Fellows, the summer fellowship is their first experience in the industry environment. The change in culture, work habits, and resources can be overwhelming at first. A better understanding of the skills needed to succeed in this different working environment is one of the most common outcomes reported by the teachers. About 90% of the teachers each year report that they gained specific and substantial information about careers, the skills needed to successfully work in mathematics and science careers, and the educational qualifications needed for these careers. This type of information is not generally available (first-hand, at least) to teachers, as noted by the 35% of all Teacher Fellows who listed "knowledge of industry" as the primary benefit of IISME participation (1991 follow-up survey). The knowledge of industry and careers gained during the summer represents the set of information that teachers are perhaps most eager to share with their students. And, given the dearth of career counselors (419 students to each counselor in California) and career information available to students, this area is one of considerable interest to industry sponsors.

SUBJECT AREA KNOWLEDGE

Teachers also note changes in their knowledge of their subject areas. Teachers who work in laboratory settings, or on research and development efforts, learn about the "cutting edge" of research in their fields. Regardless of the type of job they perform, they see myriad examples of the ways concepts and skills in their subject area are interwoven and applied in various contexts. This experience gives teachers (about 80% each year) a new perspective on their subject area that, in turn, gives them new insights on how to organize and teach their subject in the high school classroom.

It is clear that, at the end of the summer, the teachers feel their experience has been worthwhile. They have learned new skills and gained new insights into how mathematics and science concepts are used in current research, manufacturing, and product development. The question then becomes, what do teachers do with this knowledge and experience when they return to their schools and classrooms?

CLASSROOM TRANSFER

Over the years, Teacher Fellows have identified areas of classroom instruction that they have modified as a result of their summer experiences in industry. The cumulative percentages of teachers who have reported changes in four categories of instruction (career counseling, skills development, content revisions, and access to industry) were reported in Table 3. The following sections describe typical changes the teachers have reported in follow-up surveys, Action Plans, and Implementation Reports. Evaluation data over the past two years have indicated notable increases in teachers' emphases in some areas (e.g., career counseling and skills development); these changes correspond to an increased emphasis on these areas in the program materials and requirements.

CAREER COUNSELING

As might be expected, nearly all IISME Fellows return to their classrooms with a wealth of information about careers available in mathematics and science related fields, and the education and training needed to pursue those careers. While not career counselors *per se*, teachers do share considerable information with their

students regarding possible career paths and they talk with students about which courses to enroll in, types of college majors, technical training, and the like.

The majority of teachers each year report that they share "career information" with their students. This may take the form of informal references to the types of jobs teachers observed in their summer work environment, or more formal presentations based on information gathered during the summer fellowship. Some teachers, for example, conduct formal surveys of industry colleagues regarding their work, their educational backgrounds, and on-the-job training—and then present the results of these surveys to their students. Teachers may also invite Industry Mentors to visit the classroom and talk with students about "what it's like" to be a scientist, technician, or engineer.

Beyond information about specific careers, teachers also talk with students in a more general way about the skills students will need to compete in the workforce. Teachers focus on the types of technical skills (such as ***"the absolutely universal requirement of computer literacy"***) students will need for future jobs. Or, teachers draw upon their experience to offer advice to students about the importance of "life long" learning *vis-a-vis* career growth and development. One teacher, for example, felt it was important to make students aware of the importance of risk-taking:

> *I believe I took a risk by taking the IISME job. I didn't believe my skills matched the job description and hence I was unsure of success. I am still not sure of success, but I have certainly learned a great deal, nonetheless. No risk...no gain. Students must be encouraged to not always remain in an intellectually "safe" environment.*

In the past two years, we have placed more emphasis on the desirability of improved career education for students and on the resources available in industry to assist teachers in providing relevant, up-to-date information to students. As shown in Table 3, nearly all (96-97%) of the teachers reported increased use of career education in their classrooms in 1989-90, as compared to only 60% in previous years.

SKILLS DEVELOPMENT

In a related vein, IISME Fellows' heightened awareness of the importance of team-work and of good communication skills, work habits, and problem-solving abilities in the workplace encourages them to emphasize these skills more in their classrooms.

Industry sponsors also stress the importance of students learning these skills as early as possible. IISME began actively endorsing these skills as desirable areas of classroom improvement in 1989; these areas were formally defined as IISME Thematic Areas (recommended areas of focus for Action Plans) in 1990. As shown in Table 3, over 90% of the teachers in 1990 specifically included skills development as part of their formal curriculum, as compared to only 70% in previous years.

While teaching communication skills is not commonly the domain of mathematics, science, and computer science teachers, 96% of the 1990 IISME Fellows report an increased emphasis on these skills in their instruction. For example, teachers require students to present oral reports on their projects, or to produce more written reports on their work.

In the area of work habits, many IISME Fellows (about 90% in 1990) try to reinforce the importance of promptness, of self-discipline, and of completing assignments on time.

Teamwork has proven to be an interesting area of discussion for IISME teachers. While most were familiar with cooperative learning through staff development workshops, Teacher Fellows tend to develop a different view of the purposes and processes involved in working together in the industry setting. The teachers see that in industry the successful completion of a project ***requires*** the input, cooperation, and commitment of various professionals who bring unique perspectives and skills to the project. Teamwork requires good communication skills (both oral and written), the ability to interact and work well with others, and a sense of responsibility for completing one's part and adhering to deadlines.

Over 90% of the 1989 and 1990 Fellows implemented projects that required teamwork in their classes. Although teachers faced the problems inherent in cooperative learning situations (classroom management, grading, etc.), their summer experiences convinced them of the vital importance of teaching their students the skills necessary for the inevitable teamwork situations their students will encounter in their future jobs and careers.

UPDATING CONTENT

Another common strategy teachers use to apply their IISME experience to the classroom is including examples from industry to illustrate concepts. As many

teachers have said: *"Now I finally have an answer to the age-old question, 'Why do I have to learn this?'"* Using current examples of how concepts and skills are really used makes the subject more interesting and relevant to students. Students begin to see that textbook facts do have a purpose. And lectures peppered with illustrations gleaned from the space industry, or computer firms, or nationally known corporations enliven class discussion.

While nearly all IISME Fellows report using examples and illustrations from their industry experience, many also draw upon their summer work to revise the content of lectures and laboratory activities. Early in the IISME program, chemistry teachers recognized the need to introduce the topic of polymers into their high school courses, for example. Physics teachers have introduced units on electronics. Teachers may adjust the amount of time given to certain topics already in the curriculum, to more accurately reflect the concepts drawn upon in current research and development. When possible, teachers also incorporate more technology into their curriculum (to reflect the universal use of computers in all areas of the workforce, for example). Some teachers describe the laboratory equipment they worked with, or even use new equipment in their classroom laboratory (purchased by or on loan from their corporate sponsor). Teachers strive to integrate mathematics and science concepts, partially in response to the increased emphasis on such integration in curriculum guidelines, but also because they see the lack of "subject boundaries" in applied industry work. As in the area of skills development, we have seen an increase in the number of teachers (80+% in 1989-90 compared to 50% in 1985-88) who have incorporated these types of content revisions into their curriculum (see Table 3).

Teachers also take a different view of problem-solving, as a result of their IISME experience. Many teachers have noted that workplace or "real-world" problems are more challenging and complex than the contrived problems they use for demonstration purposes in the classroom. In response, most IISME Fellows devise strategies for modifying assignments or class projects to provide more challenging, open-ended problems for students to tackle. Some teachers develop assignments based on work they completed during the summer. Others apply the idea of "real-world" situations to projects they design. As one example, a mathematics teacher assigned groups of students the task of planning a public park and presenting their plans to a mock city council for approval. Students were given budget and lot site parameters and free rein to develop appropriate planning group roles.

ACCESS TO INDUSTRY

Over the past two years IISME has explicitly encouraged teachers to continue their relationships with their Industry Mentors and to draw upon the resources and expertise of Mentors in planning classroom activities. As a result, 73% of 1990 Fellows (compared to 50% or less in previous years) said they had maintained ongoing contact with their Mentor during the school year. Fifty percent of 1990 Teacher Fellows (compared to an average of 30% in previous years) reported that industry personnel had visited their schools and classrooms during the academic year. Some teachers arrange for their students to tour industry facilities and meet the industry personnel the teacher worked with over the summer. While these tours are interesting and very enlightening for students, the logistics involved (along with safety issues) prevent all but about 30% of the teachers from taking advantage of this type of opportunity.

TEACHER RETENTION

As mentioned in an earlier section of this report, many industry sponsors and educational leaders were at first concerned that teachers would leave teaching and join the ranks of industry, once they completed their summer fellowships. We are pleased to report that this is not the case. In fact, 40% of the teachers in a 1991 follow-up survey of all former IISME Fellows reported that the IISME experience encouraged them to stay in the teaching profession. Many teachers each summer tell us that the industry experience, while stimulating and challenging, serves to remind them of the special challenges and rewards of teaching. In short, the teachers reaffirm their commitment to their students and to the teaching profession.

In the 1991 survey sent to all Teacher Fellows, we found that 88% are still teachers; another 3% are in related careers in education; 2% are on personal leave or have retired. Only 6% of the respondents had moved to industry jobs (at least two of these as a result of massive layoffs and budget cuts in local school districts in the past year). These figures translate to an annual attrition rate of about 5% per year, which corresponds to the national attrition rate of 5-6% (U.S. Department of Education, June, 1991) and is slightly lower than the estimated California rate of 8% (Math, Science, and Foreign Language Instruction: Recent Changes and Prospective Trends. PACE Policy Paper No. PP88-2-1, UC, Berkeley, 1990).

IMPACT ON STUDENT AWARENESS AND ACHIEVEMENT

Over the past five years, we have collected a wealth of information from teachers and industry personnel on their perceptions of and reactions to the program. IISME staff and industry sponsors are convinced that IISME is a strong professional development experience for teachers and that teachers make use of the industry resources and ideas to enhance their instruction and career counseling. Industry sponsors have seen the benefits of participation for their companies, as well.

However, we have virtually no information on student outcomes (knowledge, attitudes, awareness of careers, etc.) as a result of their teachers' industry experiences. Program resources and substantial methodological obstacles have prevented implementation of more "summative" evaluation approaches to date.

However, documenting the impact of the IISME experience on the students of Teacher Fellows remains an important goal of the program. Currently, IISME staff are working with the *ad hoc* IISME Education Committee (composed of teachers, educational consultants, and industry personnel) to develop a comprehensive strategy to address these questions about the longer-term effects of IISME participation.

PROGRAM REPLICATION

IISME's founders envisioned that IISME, as a mature program, would be part of a network of more than 25,000 teachers at local levels across the nation, reaching more than four million students annually.

In 1986, San Diego formed a fellowship program for teachers patterned after IISME. In 1987, Los Angeles followed suit. In 1988, IISME received a grant from the Hearst Foundation to support replication efforts. Visits to and from other sites, telephone consultations, and exchange of materials led to the formation of several other IISME "sister" programs. Programs based on the IISME model are located in Colorado, Kansas, Southwestern Michigan, Sacramento, and Wisconsin.

In 1989, the Triangle Coalition for Science and Technology Education worked with IISME to marshall local interest in Detroit, resulting in the formation of Michigan Industry Initiatives for Science and Math Education. The success of this collaboration led the Triangle Coalition to seek funding from the National Science Foundation and NASA to further replicate the IISME model. This project has resulted in eleven new IISME-like programs in Alabama, Alaska, Delaware, Florida, Georgia, Louisiana, Mississippi, Oregon, Texas, Virginia, and West Virginia.

Each of IISME's "sister" programs is locally managed and maintained, and many have unique characteristics. IISME asks those wishing to use the trademarked IISME name to meet the following criteria: 1) be industry initiated and driven; 2) include a strong educational component to provide support during the summer and follow-up during the school year; 3) involve high school science, mathematics, and computer science teachers in paid, multi-week, meaningful assignments with mentored supervision; and 4) have clearly defined objectives and measurements of success.

IISME hosted a national meeting at the Lawrence Hall of Science on October 2-4, 1991 to bring together representatives from the new IISME affiliates as well as representatives from more-established industry, government laboratory, and university-based summer fellowship programs around the country. Representatives from these partnerships compared strategies for achieving classroom change, building and sustaining partnerships, and evaluating success.

We hope the meeting will lead to stronger ties within the mathematics and science education community, resulting in better communication, less duplication of effort, and better dissemination of new ideas.

Future Directions

Despite the successes chronicled in earlier sections of this report, the need that IISME was created to fill has in no way diminished since 1985. Consequently, IISME's Board of Directors, Strategic Planning Committee, and staff are working to develop a cohesive plan that leverages IISME's resources more effectively toward improved mathematics and science education in our schools.

In terms of short-term operational goals, IISME's Board of Directors has directed staff to: 1) develop sufficient fellowship opportunities to allow the program to operate at a break-even level (approximately 115 fellowships given current staffing and program offerings) in order to eliminate the need for additional fundraising; and 2) bring the reserve fund up to $70,000 (or approximately six months operating costs). The reserve fund balance was $55,000 at the close of the 1990-1991 fiscal year.

Vis-a-vis longer-term programmatic goals, IISME's Strategic Planning Committee is currently developing a plan to implement program expansion or refinement in five key areas. The five areas of focus are:

- K-8 Extension
- Teacher Professional Development
- Classroom Tools and Resources
- Visibility and Program Replication
- Evaluation

K-8 Extension

IISME is a demonstrably successful professional development program primarily for high school teachers. Yet educational research shows that many students turn away from mathematics and science long before they reach the high school level. In order to have the greatest possible impact on these students, we must reach them sooner. Consequently, IISME is planning to recruit teachers from earlier grade levels for fellowships and educational offerings. In the short term, we are targeting middle and junior high school teachers because they can easily fit into the program as it currently exists. Our long term goal is to eventually expand the

program to elementary school teachers as well. First we must determine how we can marshall our resources to meet the needs of these teachers and their students.

TEACHER PROFESSIONAL DEVELOPMENT

Expandion of opportunities for teacher professional development is a key IISME strategic objective. Our goal is to reach a broader range of teachers, including teachers of color, teachers working with students of color, and teachers who normally do not participate in professional development programs. We plan to expand the professional development opportunities we offer to those teachers who currently participate in our programs as well. Three practical approaches we will pursue are increasing Academy participation, expanding Academy offerings, and providing a means for teachers to take advantage of corporate training programs.

CLASSROOM TOOLS AND RESOURCES

The current state of educational funding in California allows teachers to buy few of the materials necessary to teach hands-on laboratory science. Yet, the California Department of Education recently published a new Framework for Science Education that mandates ***increased*** use of laboratory exercises. Given this situtation, one of our strategic goals is to stimulate and coo.dinate contributions of surplus industry equipment and supplies to schools. As a corollary, we will work to strengthen direct linkages between industry and students in the classroom.

Teachers often lack the information and resources needed to pursue education reform, grant opportunities, and leaderships positions. In the future, we hope to expand IISME's role as a broker of these resources by improving communication through such media as IISME-NET and the IISME Academy newsletters.

VISIBILITY AND PROGRAM REPLICATION

Replication has been an IISME priority since the program's inception, and the success of this effort is reflected in the twenty-two IISME "sister" programs operating nationwide. Support for expansion of the program model nationwide continues to be one of our key strategic objectives. In addition, we are exploring strategic alliances

with other organizations in order to reduce duplication of effort and leverage IISME's resources to greater effect. We also plan to formulate a multi-year, multi-pronged public relations strategy to increase program visibility within the corporate community, the teaching community, and the public as a whole. These efforts should help both in industry and teacher recruitment.

Evaluation

Evualation of program effectiveness is an essential part of the IISME model. As was discussed in the last chapter, we feel we have made significant progress in determining the effect of the IISME experience on teacher knowledge, attitudes, and instructional strategies. We will continue these proven evaluation strategies. We also plan to develop strategies to assess the impact of IISME on students themselves. In the near term, we will prepare case studies documenting innovative and effective applications of the IISME experience in classrooms, with special emphasis on students' responses. A task force of teachers and education specialists will help us develop longer-term strategies for evaluating school-level changes and the impact of the program on students.

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APPENDIX A

IISME BOARD OF DIRECTORS

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APPEMDIX A

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APPENDIX B

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Tandem Computers
Triton Biosciences
Unisys
United Technologies
Watkins-Johnson
Westinghouse
Xerox

APPENDIX D

SUPPLEMENTAL MATERIALS AVAILABLE UPON REQUEST

1. List of IISME Affiliates and Sister Programs
2. Action Plan Catalogue
3. List of Jobs by Company
4. Orientation Manual
5. Coordinator's Manual
6. Sample Industry Solicitation Letter and Brochure
7. Sample Teacher Application and Brochure
8. IISME-NET Documentation
9. Survey Instruments
10. Sample IISME Academy Flyers
11. Sample Presentation Overheads
12. Sample Company and Teacher Contracts
13. Sample Annual Program Reports

Acknowledgments

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